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A REVIEW ON ATTENTION DEFICIENT HYPERACTIVITY DISORDER

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Abstract: Attention Deficiency hyperactivity complaint(ADHD) is a neurodevelopmental complaint in which cases present inattention, hyperactivity, and impulsivity. The etiology of this condition is different, including environmental factors and the presence of variants of some genes. Still, a great diversity exists among cases regarding the presence of these ADHD- associated factors. also, there are variations in the reported neurophysiological supplements of ADHD. ADHD is constantly treated pharmacologically, producing an improvement in symptomatology , albeit there are cases who are refractory to the main pharmacological treatments or present side goods to these drugs, pressing the significance of developing other remedial options. Differentnon- pharmacological treatments are in this review addressed, chancing different results regarding effectiveness. Altogether, ADHD is associated with different etiologies, all of them producing changes in brain development, leading to the characteristic symptomatology of this condition. Given the eclectic etiology of ADHD, discussion is presented about the convenience of personalizing ADHD treatment, whether pharmacological ornon- pharmacological, to reach an optimum effect in the maturity of cases. Approaches to personalizing both pharmacological remedy and neurofeedback are presented.

Keywords: ADHD , neurodevelopmental disorder, medications, inattention, hyperactivity, Impulsivity.

➢ INTRODUCTION

Attention deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder (NDD) characterized by inattention, hyperactivity, and impulsive behavior. Depending on the severity of the symptoms, it can be divided into three subtypes: predominantly inattentive, predominantly hyperactive-impulsive, and combined. ADHD affects 5.9% to 7.1% of children and 1.2% to 7.3% of adults worldwide.

While most studies focus on children aged 7 to 17, it is important to note that this condition can also affect adults. It has been suggested that the number of adults suffering from ADHD has increased in the last 20 years. A portion of this increase can be attributed to the persistence of ADHD symptoms in adults in 76% of

diagnosed patients. ADHD poses significant challenges for academic, personal, and occupational performance . To find an appropriate treatment for ADHD, as with any other condition affecting brain function, it is necessary to first understand its physiological basis. ADHD, like other NDDs, is caused by abnormal neural development, which affects neurogenesis, synaptogenesis, myelination, neuronal and glial proliferation and migration. Despite the fact that symptoms appear in childhood, neuronal development is affected from early embryogenesis .ADHD has a diverse etiology—gestational, perinatal, and genetic factors have all been linked to ADHD incidence. However, each patient only exhibits a subset of them .[1]

➢ ADHD PATHOPHYSIOLOGY

Attention-deficit hyperactivity disorder (ADHD) is one of the most common neurobehavioral problems afflicting children aged 6 to 17 years old; its prevalence in this age group is increasing.

In the United States, this age group is thought to range from 2% to 18%. ADHD is a heritable, chronic neurobehavioral disorder characterized by hyperactivity, inattention, and impulsivity.

There are now three subtypes of ADHD: hyperactive impulsive, inattentive, and a combined type, which is characterized by a combination of the first two subtypes. Children and adolescents with ADHD go through difficult formative years. Because of their impulsive behavior and slower rates of information processing, they perform poorly on standardized tests, receive lower grades, and are more likely to drop out of school. Impulsiveness also increases the risk of motor vehicle accidents and spontaneous sexual encounters, which could explain why there are more of them of teen pregnancies and incidence of sexually transmitted diseases in these individuals. Lower self-esteem causes problems in social relationships, a proclivity for substance abuse, and issues with law enforcement.

Furthermore, ADHD is frequently associated with one or more coexisting such as oppositional defiant disorder (ODD), major depressive disorder (MDD), and anxiety disorders, posing additional challenges for these individuals. Approximately 60% to 80% of ADHD symptoms persist into adulthood. As a result, ADHD is more than just a childhood disorder. That resolves on its own after adolescence .Adult manifestations include poor job performance, lower socioeconomic status, and marital/relationship issues.

Thus, the lower quality of life in people with ADHD necessitates treatment to avoid the numerous issues

that these people face as children, adolescents, and adults. [2]

Due to associated deficits in executive cognitive functioning, ADHD has been conceptualized as a disorder affecting "frontal" circuitry. Diffuse abnormalities in children and adults with ADHD have been documented by structural imaging studies. A large study by Castellanos and colleagues 55 found that the total cerebrum, cerebellum, and the four cerebral lobes were smaller and did not change over time. A structural MRI study 56 in adults with and without ADHD found a smaller anterior cingulate cortex (ACC) and dorsolateral prefrontal cortex (DLPFC). The DLPFC is in charge of working memory, which is the ability to retain information while processing new information. These distinctions are thought to account for ADHD deficits in goal-directed and on-task behavior. Shaw and colleagues 57 discovered an increase in cortical thickness in ADHD patients. The development of the brain from sensorimotor to associative areas was similar in children with and without ADHD. In those with ADHD, however, the age of peak development was delayed. Makris and colleagues 58 demonstrated, using the same measure of cortical thickness data in adults, that cortical thickness is not normalized and that the areas of the brain that are affected in children with ADHD remain affected in adulthood. In this study, adults with ADHD had thinner cortical thickness measurements in the DLPFC, parietal areas, and ACC than adults without ADHD.
Functional magnetic resonance imaging (fMRI) has been used to study brain activity in people with ADHD during selective cognitive challenges. According to one study that used a neuropsychological test to

measure brain activity (go/no-go), both youth and adults with ADHD had lower activity in the frontostriatal regions of the brain that are important for inhibitory control and attention (prefrontal cortex and caudate) Adults with ADHD also activated non-frontostriatal regions more than controls (ACC, parietal areas). In both children and adults with ADHD, the amount of brain activation observed correlated closely with task efficiency.

Interestingly, medication has the potential to normalize some of these functional deficits. Bush and colleagues published a study that found that 7 weeks of methylphenidate treatment normalized activation in the ACC 61. At follow-up, those who received medication had higher activation of the ACC and DLPFC compared to those who received placebo. As a result, areas of the brain that were underactive in adults before treatment normalized after treatment. [3]

➢ EPIDEMOLOGY OF ADHD

a. Age-dependent prevalence of ADHD

ADHD prevalence varies with age. A common disorder among young people around the world is ADHD. A meta-analysis encompassing over 100.Research found that 5.3% (95% CI: 5.01–5.56) of children and adolescents globally suffer from ADHD.

This variation between studies was explained by three methodological factors: the selection of diagnostic criteria, the information source, and the inclusion of a criterion for both symptoms and functional impairment for diagnosis. A later meta-analysis found that, after accounting for these variables, there are no appreciable differences in the prevalence of ADHD across Europe, Asia, Africa, the Americas, and Australia. Moreover, there is no proof of a growth elsewhere in the world in the actual prevalence of ADHD during the previous three decades. The widespread belief that ADHD is overdiagnosed in the US may not be supported, despite the fact that both overdiagnosis and underdiagnosis are prevalent issues in medicine.
Adults are not immune to ADHD. Even while most people with ADHD will not still match all of the criteria for the disorder, there is a strong likelihood that adults with ADHD will continue to experience functional impairment or subthreshold (three or less) impairment symptoms. Recent changes to the diagnostic criteria have affected the prevalence of ADHD in both adult and pediatric populations.

b. Socio-demographic factors

When assessing the prevalence of ADHD, age is not the only aspect to be taken into account; sex, ethnicity, and socioeconomic level are also significant considerations. Males are more commonly affected by ADHD in children and adolescents, with a male-to-female sex ratio of 4:1 in clinical trials. This gender disparity virtually vanishes in adulthood14, potentially as a result of treatment-seeking patients' referral biases or sex-specific effects of ADHD during the duration of the condition.Families with ADHD16 may be disproportionately represented in socioeconomic adversity as a result of underemployment.

Finally, despite the fact that the genuine frequency of ADHD is not ethnically variable, several studies have found conflicting links between ethnicity and ADHD because of care-seeking habits and other obstacles that disproportionately affect specific ethnic groups. [8]

➢ DIAGNOSIS OF ADHD

Although the diagnostic criteria for ADHD have evolved over time, the assessment and evaluation tools have remained largely unchanged. ADHD is still primarily a clinical diagnosis. A comprehensive history of prenatal, perinatal, and family history; school performance; environmental factors; and a detailed physical examination are currently recommended for diagnosing possible ADHD. During the physical examination, special attention should be paid to vital signs (cardiovascular, skin, thyroid, and neurologic systems, including motor coordination assessment), and a mental health assessment should be performed to look for comorbid conditions.

Unfortunately, the objective assessments currently available for ADHD are of limited use in clarifying the diagnosis, including neuropsychological tests (with a low strength of evidence14) and EEG and neuroimaging (with insufficient evidence14). Because animal models, neuroimaging studies, and pharmacologic studies support the involvement of dopaminergic and adrenergic derangements in ADHD, the scientific community has also been interested in understanding how neurotransmitter systems are involved in ADHD.

However, no evidence-based methods for assessing these neurotransmitter systems have been developed and demonstrated to be useful in ADHD diagnosis. Although the heritability of ADHD is estimated to be 76%, no specific genetic pattern has been shown to be necessary or sufficient for the disorder. As a result, identifying genes associated with ADHD has been difficult, and genetic testing is currently ineffective for diagnostic purposes.[4]

➢ CAUSES OF ADHD

ADHD, like other common medical and psychiatric disorders (for example, asthma, schizophrenia), is influenced by a number of genes, non-inherited factors, and their interactions. There is no single cause of ADHD, and being exposed to a risk factor does not always result in the disorder. This means that any given risk factor will only be observed in a subset of cases and will also be found in unaffected individuals. Furthermore, risk factors that contribute to the etiology of ADHD may not be the same as those that influence its course and outcomes. Another layer of complication is that genetic factors can have an indirect risk effect through interactions with environmental factors. Genes can alter sensitivity to environmental risks such as toxins or psychosocial adversity (gene-environment interaction). Inherited factors can also influence the likelihood of being exposed to specific environmental risks (gene-environment correlation; see below). This means that the effects of environmental and genetic risk cannot be considered separately. [5]

A] ENVIRONMENTAL FACTORS:

1] Preconceptional , Gestational, and Perinatal Conditions:

ADHD is a significant risk factor for premature birth, as it has been reported that it occurs 2.6 to 4 times more frequently in babies born with low or very low weight. Premature birth is associated with changes in neurogenesis and cell death which are linked to decreased cortical expansion in ADHD patients.

Inflammation is one possible explanation for the increased risk of ADHD in preterm children; an increase in inflammation-related molecules is associated with an increased risk of developing ADHD symptoms Nutrient intake during pregnancy is critical for proper brain development. The polyunsaturated fatty acid docosahexaenoic acid (DHA) plays an important role in neural development by promoting the proliferation and differentiation of neural progenitor cells. Reduced DHA levels during brain development have been linked to ADHD and other neurodevelopmental disorders , and lower serum DHA levels have been reported in adult ADHD patients . Furthermore, a pregnant mother's malnutrition or immune activation is a risk factor for ADHD and other neurodevelopmental disorders. High sucrose consumption during pregnancy may be linked to an increased risk of ADHD. A rat study found that high sucrose intake during pregnancy caused ADHD-like symptoms in the offspring, who displayed increased locomotor activity, decreased attention, and increased impulsivity. Furthermore, the offspring had higher levels of dopamine transporter (DAT) and lower levels of dopamine receptors and mRNA expression in the striatum [1]

2] Heavy Metal Exposure:

We investigated the exposure to metals such as Mn, Pb, Cd, Hg, Sb, and Bi and its relationship to the specificity of ADHD symptomatology in this study, measuring severity and cognitive function with the WISC-IV. Pb levels were found to be positively correlated with ADHD.

Inattention, hyperactivity, and impulsivity are examples of symptomatology. Previous research has shown that Pb disrupts the dopamine pathway, which is one of the major neurotransmitter pathways involved in ADHD, resulting in dopaminergic neuron damage and disruption of calcium-dependent neurotransmitter homeostasis . Previous research has found a link between Pb and ADHD symptoms or ADHD diagnosis. Our findings support this viewpoint, implying that Pb plays a role in attention and behavior control. Nonetheless, our cross-sectional study was unable to determine the relationship between Pb and ADHD. For example, socioeconomic status (SES) influences Pb risk at the same time. As a result, there may be a significant association between Pb levels and ADHD.

Furthermore, epidemiological studies revealed that the prevalence of ADHD had not decreased, but rather increased , over the past decades, as the phase-out of lead-based gasoline became common public health policy in most countries.

Another intriguing finding in our study was that the highest Sb levels were found in the ADHD-H/I group and were lower in the ADHD-I and healthy control groups. Furthermore, Sb levels correlated positively with inattention, hyperactivity/impulsivity, and oppositional scores.

Teachers rated it. Sb may cause peripheral neurotoxicity , cerebellar ataxia and genotoxicity according to other experimental studies and case reports. However, research on the toxic effect of Sb on neurocognition is lacking. One meta-analysis found a link between Sb levels and autism, but there was no neurobiological evidence . Our findings serve as a reminder to clinicians to pay close attention to the potential effect of Sb on ADHD.

We also discovered that Hg levels were positively related to hyperactivity/impulsivity scores as rated by parents. Hg has a negative impact on enzymes, cellular membrane function, and neurotransmitter levels. A meta-analysis was carried out byYoshimasu demonstrated a significant link between Hg exposure in the environment and ADHD [. It is worth noting that the majority of those studies assessed their outcomes using a variety of neurodevelopmental indicators, such as ADHD symptoms rated by Conner's scale, rather than DSM-IV-defined psychiatric diagnostic categories of ADHD.

Furthermore, the half-life range of these heavy metals was widely dispersed. Sb, for example, had the shortest half-life after exposure at 95 hours, but Cd had the longest half-life for decades. A single urine sample measurement may reflect recent exposure. However, determining the effect of heavy metals during the critical period of neurodevelopment is difficult. Second, using urine samples to measure chemicals may be associated with greater individual variation, particularly in Pb. Furthermore, urinary Pb levels are less sensitive at low exposure levels (i.e., 10 g/dL).

Our findings suggest a link between metals and ADHD susceptibility, particularly for Pb, Cd, and Sb. Pb levels are especially related to children's neurocognitive function. These findings imply that children should avoid heavy lifting metal exposure and avoid the negative effects of metals on children's neurodevelopment. Taiwan, on the other hand, is a small and densely populated country. The line between the cultivated field, the industrial area, and the residential area was not always clear. As a result, it is critical to enact public health policy to reduce heavy metal exposure in the environment. [6]

B] GENETIC FACTORS

The rationale for genetic susceptibility to ADHD (or any other behavior) is fairly straightforward We anticipate that a genetic variation in the DNA of a specific gene will result in neuronal cellular variation. This variation could be in the neuron's differentiation, development, structure, or function. Such a change will then result in variation at the brain or "system" level, such that there are changes during system differentiation, development, structure, or function that lead to changes in behavior or phenotype. When considering genetic susceptibilities for complex traits such as behavioral disorders, we anticipate that variations in genes will lead to variations at the cellular level, which will then lead to variations at the system level, either due to changes during system development or in the adult organism. The environment may play a significant role in the development of a complex disorder. This diagram also shows how genetic, phenotypic, and environmental complexities complicate the genetic analysis of ADHD.[7]

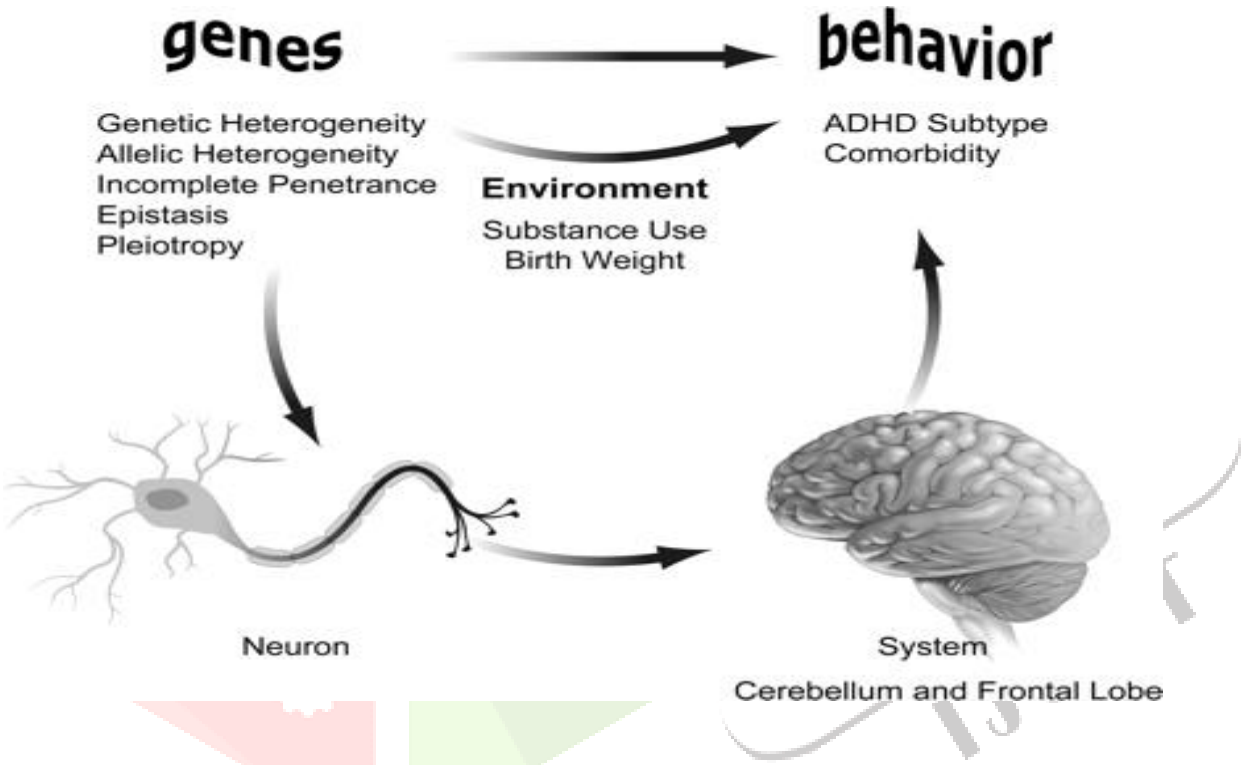

Fig 1 : Causes of ADHD

- **SYMPTOMS OF ADHD**

There are three main types of ADHD:

- Predominantly inattentive presentation.
- Predominantly hyperactive/impulsive presentation.
- Combined presentation.

1] Inattentive type :

The term" inattentive" describes problems with association, focus, and staying on task. Six(or five for those who are 17 times of age or aged) of the following symptoms must constantly do in order to be diagnosed with this type of ADHD

- Hacks attention to detail and carelessly completes tasks for work or academy.
- Has trouble maintaining attention on tasks or conditioning, similar as lengthy readings, lectures, or exchanges.
- Appears to be away and doesn't feel to hear when spoken to.

- Disregards directions and fails to finish jobs, chores, or training(may begin tasks but loses focus fluently).
- Has trouble keeping effects organized(poor time operation, sloppy, disorganized work, missing deadlines,etc.).
- Avoids or detests doing things that call for prolonged mental effort, like filling out forms and writing reports.
- Frequently misplaces items that are necessary for daily living or tasks, including books, school papers, wallets, cell phones, and spectacles.
- Is prone to distractions.
- Forgets to complete everyday duties like errands and chores. It's common for older adults and teens to forget to make appointments, pay bills, and return calls.

***2] Hyperactivity/ Impulsive Presentation*:**

Excessive movement, including fidgeting, having too much energy, moving around a lot, and talking a lot, is referred to as hyperactivity. Impulsivity is the term used to describe choices or actions made without considering the repercussions. Six (or five for those who are 17 years of age or older) of the following symptoms must frequently occur in order to be diagnosed with this type of ADHD:

- Wriggles in the seat, fidgets with hands or bases, or gates them.
- Unfit to remain seated(at work or in a classroom).
- Runs around or climbs in places that aren't suitable.
- Unfit to play or engage in quiet rest conditioning.
- Always" in stir," as however propelled by a motor.
- Addresses exorbitantly.
- Answers questions hastily(for illustration, by finishing other people's rulings or by being intolerant to speak in exchanges).
- Finds it delicate to stay for their turn, for illustration, when standing in line.
- Interrupts or intrudes upon others(e.g., begins using other people's property without authorization, or interrupts games, exchanges, or other conditioning).
- Teens and grown-ups who are aged could take over what others are doing.

3] Combined Presentation:

When the criteria for both the hyperactive/impulsive and inattentive types of ADHD are satisfied, this type of ADHD is diagnosed.

Usually, primary care physicians or mental health professionals diagnose ADHD. A comprehensive psychiatric and medical history, family history, information about education, surroundings, and upbringing, a description of symptoms from the patient and caregivers, and the patient, caregivers, and teachers filling out scales and questionnaires are all part of a psychiatric evaluation. In order to rule out other medical conditions, it might also involve a referral for medical evaluation.

It is noteworthy that a number of conditions, including learning disabilities, mood disorders, anxiety, substance abuse, head trauma, thyroid issues, and use of certain medications like steroids, can resemble ADHD. Additionally, oppositional defiant disorder or conduct disorder, anxiety disorders, and learning disorders are among the mental health conditions that may co-occur with ADHD . Consequently, it is crucial to have a thorough mental assessment. Routine imaging or specific blood tests are not available for the diagnosis of ADHD. In order to determine the severity of their symptoms, patients may occasionally be referred for additional psychological testing (such as neuropsychological or psychoeducational testing) or undergo computer-based testing. [9]

➢ TREATMENT OF ADHD

For more than 45 years, the cornerstone of treatment for children with ADHD has been behavioral interventions combined with stimulant medications. Bradley19 was the first to note that children hospitalized for behavioral issues behaved better after taking benzo[ine] in 1937. Although dextroamphetamine was also approved in 1937, it wasn't until the middle of the 1950s that it attracted attention as a treatment for children with mild brain impairment.Twenty When methylphenidate was made accessible in 1954, amphetamines lost favor and methylphenidate gained popularity. 62 blinded, placebo-controlled studies demonstrating the safety and effectiveness of stimulant medications date back to 197722. By 1999, over 300 high-quality, rigorous studies had demonstrated their benefits and safety. Since then, hundreds of more thorough studies have continuously attested to their safety and effectiveness when used in the therapeutic dose range for the children of 4 years of age to adulthood.

It has also long been established that behavioral interventions aimed at changing behavior, like parent behavior management classes and school behavior management initiatives, work. The level of empirical support for the efficacy of other interventions—such as diets, herbal and other supplements, EEG training, and neuropsychological or cognitive training interventions—is not as high as that of the behavioral interventions mentioned above and the ADHD medications approved by the US Food and Drug Administration.

The National Institute of Mental Health funded the Multimodal Treatment of ADHD (MTA) study, in which researchers looked at the effects of behavioral interventions and stimulant medication in a multisite, 14-month study with 10-year follow-up surveillance. Combining behavioral therapy and medication proved to be most effective, especially in cases where comorbidity or other family issues were present, even though stimulant medication had the strongest effect on core ADHD symptoms and behavioral interventions were most well-liked by families.

Nevertheless, the degree of medication or behavioral interventions that participating families received was reduced after they left the active trial. Therefore, it has been challenging to show the long-term benefits of both behavioral therapy and medication for ADHD because neither is curative and only functions when actively administered. [10]

➢ DRUGS USED IN ADHD

The primary requirement for the study's inclusion in the review was that the study description include details regarding the use of pharmaceutical, non-pharmacological, or combination treatments for ADHD. Treatment ought to have been the study's main goal. Research involving individuals with co-occurring disorders (including anxiety, depression, epilepsy, or other health concerns) were also acceptable for inclusion as long as these disorders were connected to ADHD.

The subsequent categorization of therapies was utilized:

1) Pharmaceutical treatments:

A. Stimulant medications:

• Dopamine and norepinephrine reuptake inhibitors, such as dexmethylphendate hydrochloride, methylphenidate hydrochloride, and lisdexamfetamine dimesylate.

B. Nonstimulant medications:

• Agonfacine and clonidine, two agonists of the Apha2 adrenergic receptor.

• Atomoxetine, a selective noradrenaline reuptake inhibitor

- Additional authorized or unapproved medications for ADHD:

• Antidepressants (such as hydrochloropropion, venlafaxine, desipramine, and others).

• Antipsychotics such as risperidone, aripiprazole, and olanzapine.

2) Non-pharmaceutical methods:

A. Mental health

• Behavior management strategies (such as social skills training, cognitive behavior therapy, parent education, peer-based interventions, school interventions, classical contingency management, organizational skills intervention, etc.)

• Cognitive training interventions, such as biofeedback, working memory, attention, and cognitive training.

• Psychoeducation , as described in the works of Catala-Lopez et al. (2015), 2017; and Shrestha et al. (2020).

B. Complimentary and substitute techniques:

• Salutary and supplemental curatives(polyunsaturated fats, vitamins, minerals, amino acids, herbal remedies, homeopathic remedies,etc.)

• Mind- body curatives(awareness, yoga, tai chi, contemplation, massage, acupuncture, chiropractic adaptations, osteopathic manipulation, hypnotism,etc.)

- **Widgets :**

• Direct current stimulation of the brain(tDCS)

• Random noise stimulation(tRNS) of the brain

• Transcranial glamorous stimulation applied repetitively(rTMS)

• Transcranial glamorous stimulation in direct stir(dTMS)

• Trigeminal whim-whams stimulation applied externally(eTNS)
• VR, or virtual reality

3) Combinatorial approaches:

Similar to previous studies all data pertaining to INN, agent type, agent class, target type, mechanism of action, and FDA approval was gathered from go.drugbank.com, genome.jp, uniprot.org, and fda.gov in drug-assisted trials. [11]

Methaline hydrochloride, methylphenidate transdermal system, lisdexamfetamine dimesylate, amphetamine sulfate, dexmethylphenidate hydrochloride, dextroamphetamine sulfate, mixed amphetamine mariners , dexmethylphenidate hydrochloride, atomoxetine, guanfacine hydrochloride, clonidine hydrochloride, and viloxazine are among the twelve specifics **approved by the FDA for the treatment of ADHD.**

Risperidone, brexpiprazole, and molindone hydrochloride are three other repurposed medications that were previously approved for the treatment of other indications and **are currently being tested in clinical trials for ADHD** and two medications whose clinical development has been halted: dasotraline and facoracetam. Central nervous system stimulants, such as methylphenidate hydrochloride, lisdexamfetamine dimesylate,

amphetamine sulfate, and mixed amphetamine salts, are the most common class of medications used to treat ADHD. These drugs primarily work by controlling the levels of monoamines in the brain, primarily dopamine and norepinephrine, by blocking the sodium-dependent dopamine transporter and sodium-dependent noradrenaline transporter. Antidepressants (e.g., bupropion hydrochloride, vortioxetine, duloxetine hydrochloride, edivoxetine, reboxetine, fluvoxamine maleate, PDC-1421, dasotraline, ampreloxetine) are the class of drugs with the **greatest number of unique agents in clinical trials**.

Since antidepressants and psychostimulants share a similar mechanism of action and target similar molecules (e.g., sodium-dependent noradrenaline transporter, sodium-dependent dopamine transporter), antidepressants may be prescribed to treat ADHD in patients who did not respond to stimulants or demonstrated intolerance to them. But these drugs **haven't received FDA approval for this purpose specifically.** [11]

➢ PREVENTION OF ADHD

Primary, secondary, and tertiary are common classifications for preventive interventions.

- ***Primary preventions :***

Which stop a disease or injury before it starts, usually take the form of public health campaigns. Examples of these include the use of seatbelts in cars, vaccinations against viral infections, and encouragement of physical activity and a balanced diet to prevent obesity and cardiovascular disease. Primary prevention efforts for ADHD and other neurodevelopmental disorders include campaigns to reduce environmental toxins like lead and mercury as well as programs that support maternal health during pregnancy, like warnings against alcohol and cigarette use. While these programs won't completely eradicate ADHD, they might reduce the prevalence.

- ***Secondary preventive interventions :***

Slow the disorder's progression and/or change its trajectory to minimize complications later on. They also detect the disorder in its early stages, when it may be easier to treat. Secondary preventive measures include colonoscopies, cardiac stress tests, and mammograms as means of early detection of potentially serious illness. Early detection results in the implementation of an intervention intended to lessen (or eliminate) the likelihood of severe consequences down the road, before any serious (or, in some cases, nonexistent) symptomatology occurs. This includes early intervention services for kids who are considered to be "at-risk," like Head Start.

- ***Tertiary prevention:***

It is unlikely to be curative, but it will control or minimize complications once the disorder has shown symptoms. Treatment programs for drug and alcohol abuse, the use of insulin for diabetes, and—most pertinently in this context—parent education or psychostimulants for ADHD patients are common examples. [12]

➢ HEALTH RISK BEHAVIOUR AND ADHD

Substance use disorders (SUDs) tend to have an earlier onset, faster progression, and less remittance; individuals with ADHD have at least 1.5 times the average risk of developing dependence on nicotine, alcohol, marijuana, cocaine, and other drugs (Lee, Humphreys, Flory, Liu, & Glass, 2011). Additionally, compared to people without ADHD, they have three times higher rates of binge eating and higher rates of obesity (Spencer, Faraone, Tarko, McDermott, & Biederman, 2014). Additionally, unsafe sexual behavior, such as having multiple partners and engaging in sexual activity earlier in life, is linked to ADHD. According to Flory et al. (2006), youth with ADHD are also less likely to use contraception, which raises the risk of STIs and unplanned pregnancies.

Obesity, STIs, and SUDs are directly linked to morbidity and mortality as well as chronic health issues. SUDs also raise the incidence of mishaps, violence, and unprotected sex. These issues also lower quality of life and socioeconomic attainment, in addition to unplanned pregnancies. Given the elevated frequency of ADHD and its correlated hazards, health promotion initiatives tailored to this demographic are highly imperative and hold significant promise for improving public health. [13]

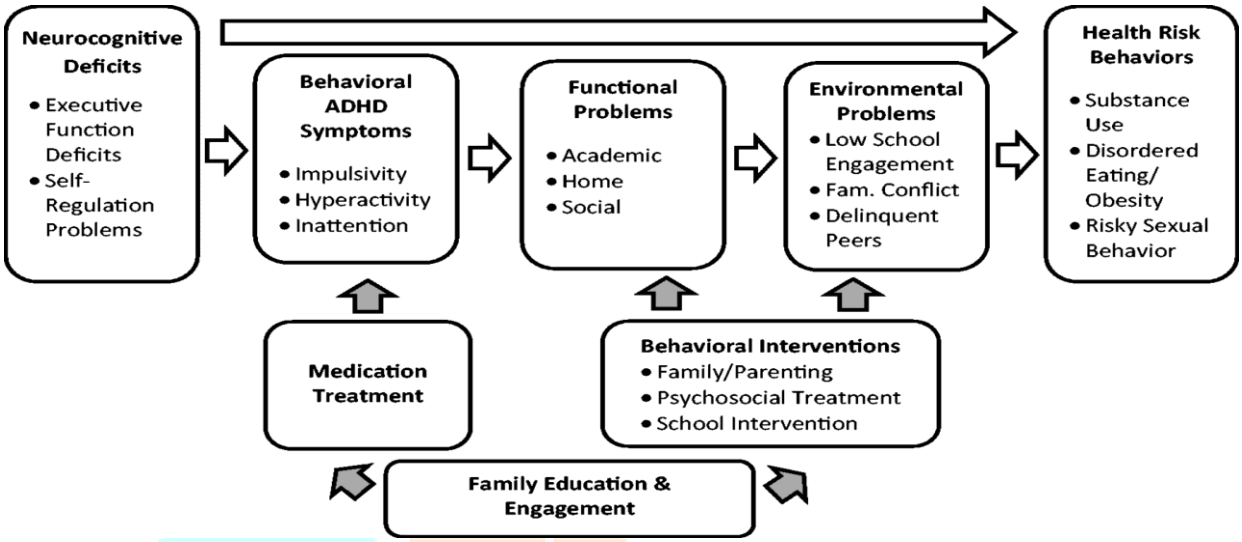

Fig 1.
Biopsychosocial model of ADHD and health risk behaviors.

➢ OTHER CONCERNS AND CONDITION WITH ADHD

ADHD frequently coexists with other conditions. In addition to ADHD, many children also suffer from other disorders like conduct issues, anxiety, depression, and learning disabilities

- ***Problems with behavior or conduct :***

Sometimes when children see adults, they become angry or defiant, or they react violently when they are upset. When these actions become severe or persistent over time, they may develop into a behavior disorder. Adolescents diagnosed with conduct disorder or oppositional defiant disorder are more likely to have ADHD than other children.

- ***Oppositional Defiant Disorder :***

One of the most prevalent disorders that co-occur with ADHD is ODD. ODD typically begins before the age of eight, though it can strike teenagers as well. The likelihood of oppositional or defiant behavior in children with ODD may be highest in the presence of familiar faces, such as family members or a regular caregiver. Compared to other kids their age, ODD children exhibit these behaviors more frequently.

A few instances of odd behavior are

1. Frequently losing their cool
2. Fighting with adults or disobeying their orders or regulations
3. Frequently becoming enraged, bitter, or desirous of hurting someone who they believe has wronged them or created issues for them
4. Purposefully upsetting other people; quickly growing irritated with other people
5. Frequently placing the blame for one's own errors or misdeeds on others

- ***Behavior Disorder :***

When kids exhibit aggressive behavior toward others and flagrant rules and social norm violations at home, school, and among peers, it is called conduct disorder (CD). Engaging in these actions may result in breaking the law and going to jail. A child is more likely to receive a CD diagnosis if they have ADHD. Compared to other children, children with CD are more likely to sustain injuries and struggle to get along with their peers.

A few instances of CD behaviors are :-

1. Breaking severe regulations, like fleeing, remaining out late when instructed not to, or missing class
2. Being harmfully aggressive, like when bullying, fighting, or mistreating animals
3. Stealing, lying, or intentionally causing harm to another person's property

- ***Learning Disorder***

A learning disorder is also present in many children with ADHD (LD). This is on top of other ADHD symptoms that can hinder a child's academic performance, like trouble focusing, paying attention, or organizing oneself.Even if a child's intelligence is unaffected, a learning disorder is defined as a definite difficulty in one or more areas of learning. Among the learning disorders are

1. Dyslexia is a reading disability
2. Dyscalculia is a mathematical difficulty
3. Dysgraphia is the inability to write
4. An ADHD and LD child's combined problems can make it especially difficult for them to do well in school. Accurately identifying every disorder is crucial to providing the child with the appropriate support.

- ***Anxiety And Depression***

Anxiety :-
Many kids worry and experience fear. It is an anxiety disorder, though, when a child has so many fears and worries that they get in the way of their play, school, or home life. Anxiety disorders are more likely to develop in children with ADHD than in those without it.

Anxiety disorders examples include

- Anxiety caused by separation: experiencing extreme fear when one is not with family
- Social anxiety refers to a person's extreme fear of going to school and other social situations.
- General anxiety refers to a person's extreme worry about the future and that horrible things will happen to them

- ***Depression :-***

All children experience sadness and hopelessness from time to time. It can lead to issues when kids experience despair and hopelessness all the time. Childhood depression is more common in children with ADHD than in children without ADHD. When an ADHD child's symptoms become out of control and start to interfere with their ability to learn or interact socially with family and friends, the child may become more depressed and hopeless.

Some common behaviors observed in children experiencing depression include :-

1. Having a constant sense of sadness or hopelessness
2. Not wanting to engage in enjoyable activities
3. Having trouble concentrating
4. Feeling insignificant or useless.

- ***Risk of injuries :-***

Compared to their peers without ADHD, children and adolescents with ADHD are more likely to suffer more serious injuries. According to research, kids with ADHD are much more likely to,

- ✓ Sustain an injury while cycling or walking
- ✓ Possess head trauma
- ✓ Injure multiple body parts and end up in the hospital due to accidental poisoning
- ✓ Be admitted to critical care units or suffer a handicap-causing injury. [14]

ROLE OF PHARMACIST

Clinical pharmacy is gaining popularity as it defines pharmacists' primary role in providing services such as medication reconciliation, therapeutic education, and participation in multidisciplinary teams to help optimize pharmacotherapeutic decisions for patients with neuropsychiatric disorders . In terms of ADHD, pharmacists can play a variety of roles in providing pharmaceutical care to patients of various ages or stages of the disorder. Before confirming the diagnosis, pharmacists may notice potential ADHD symptoms during casual conversation or a more comprehensive consultation with a patient or caretaker and then refer the patient to medical specialists for a more formal evaluation.

1. ADHD Education:

Previous research has identified several knowledge gaps regarding ADHD and its treatment, implying that more education to raise ADHD awareness is required . Patients with ADHD or their guardians are more likely to adhere to their medications and, as a result, help mitigate the symptoms of ADHD . Medication adherence is essential for disease control, resolving temporary conditions, ensuring long-term health, and improving patients' quality of life . Finally, pharmacists could play an important role in educating ADHD patients' guardians or parents, answering physicians' questions about the best agent to treat the patient, and designing the pharmacotherapeutic regimen and monitoring plan. ADHD education provided by pharmacists can assist patients in better understanding ADHD management, particularly medication side effects, onset of action, administration instructions, monitoring frequency, and requirements.

2. Optimization of Medications in a Collaborative Practice Model:

Medication optimization helps patients with medication adherence, long-term management, multiple morbidities, and polypharmacy. Pharmacists' approaches include : (i) reviewing patients' lists of prescribed medications, (ii) meticulously discussing every medicine with the patient, and (iii) reviewing the patient's medications alongside their clinical medical records and discussing the intended outcomes of the reviews .

Pharmacists and psychiatrists can work together to provide independent follow-up in ADHD clinics. Adherence to ADHD treatment is improved when clinical pharmacists are integrated into an ADHD specialty clinic. Initially, pharmacists collaborated with a psychiatrist to visit patients, and then conducted independent follow-ups with the patients. Over the course of three years, there was a significant increase in

the number of appointments, an improvement in adherence to monitoring blood pressure and heart rate, and a greater willingness to follow a clinic policy requiring patients' signatures for stimulant medication.

3. Management and Monitoring of Side Effects:

Some people may experience unfavorable side effects, necessitating administration, dose, or medicine modification. The ADHD rating scale may be useful to pharmacists in closely monitoring the effects of medication on the core symptoms of inattention, hyperactivity, and impulsivity. Sleeplessness and decreased appetite were among the side effects of pharmacological medications used to treat ADHD in children and adolescents, as were headaches, tiredness, sorrow, and euphoria. Adults who used methylphenidate or amphetamines frequently experienced headaches, decreased appetite, and sleeplessness. A recent study of ADHD medication prescribing trends and adverse drug reaction (ADR) reporting in the United Kingdom found that guanfacine had the highest number of reports for serious or fatal ADR incidents. In contrast, methylphenidate had the fewest severe or fatal side effects.

A pharmacist must understand how stimulants affect appetite and growth in ADHD children. Children who use stimulants should have their height and weight measured on a regular basis, preferably semi-annually . Both stimulants and atomoxetine have been linked to rare but serious cardiovascular side effects, such as increased blood pressure and heart rate. In ADHD patients with pre-existing cardiac problems, stimulants should be used with caution. At follow-up appointments, pharmacists should check blood pressure and heart rate, examine medication adherence, assess adverse drug effects, assess mood changes, and adjust the treatment plan, which may include ADHD, anxiety, and depression medications. [15]

➢ CONCLUSION

Attention-Deficit/Hyperactivity Disorder (ADHD) is a complex and multifaceted neurodevelopmental disorder that has received a great deal of research and clinical attention.

ADHD is a real and recognized medical condition: ADHD is not caused by laziness or a lack of discipline. It is a neurobiological disorder characterized by persistent patterns of inattention, hyperactivity, and impulsivity that can have a significant impact on a person's daily life.

There are numerous subtypes: ADHD is frequently classified into subtypes such as predominantly inattentive, predominantly hyperactive-impulsive, and combined presentation. This recognition of subtypes emphasizes the variability of symptoms among ADHD patients.

Treatment options: Behavioral therapies, educational support, and medication may be used to manage ADHD. To help manage symptoms, medications such as stimulants (e.g., methylphenidate and amphetamines) and non-stimulants (e.g., atomoxetine) are commonly prescribed.

To summarize, ADHD is a complex and widespread neurodevelopmental disorder that affects people of all ages. It necessitates meticulous diagnosis and a multidisciplinary approach to treatment. While ADHD can be challenging, with the right support and interventions, people with ADHD can live happy and successful lives. Keep in mind that future research may yield new insights and treatment options.

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